STATEMENT OF WORK

LAGOON SLUDGE TREATABILITY STUDY
NORTH BRONSON INDUSTRIAL AREA SITE
OPERABLE UNIT NO. 1
BRONSON, MICHIGAN

Prepared By

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TABLE OF CONTENTS

LIST OF TABLES

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1.0 INTRODUCTION

This Statement of Work (SOW) outlines the objectives, scope, and procedures for a bench- and pilot-scale treatability study designed to evaluate the technical feasibility and cost-effectiveness of stabilizing metal plating sludge and associated impacted soils at the Eastern and Western Lagoons of the North Bronson Industrial Area (NBIA) site in Bronson, Michigan. Stabilization has been identified as a treatment technology that may be useful in supplementing source control at the NBIA lagoons and reducing potential impacts from these lagoons on the surface water quality in nearby County Drain #30.

While being reviewed and commented upon by the U.S. Environmental Protection Agency (USEPA) and Michigan Department of Environmental Quality (MDEQ), the Potentially Responsible Party Group for Operable Unit No. 1 of the NBIA site (the "Group") will provide this SOW to prospective environmental remediation consultants and contractors to solicit detailed proposals and work plans for implementing the bench- and pilot-scale treatability study. The SOW will be revised as needed to incorporate USEPA and MDEQ comments, and additional revision to the treatability study work plan may occur based on the receipt and evaluation of bids. The results of a successful treatability study will be used: (a) as a basis to move forward with an Explanation of Significant Differences to the Record of Decision (ROD) to incorporate sludge stabilization as a component of the remedy; and (b) in the Remedial Design for NBIA Operable Unit No. 1 to define a performance-based remediation contract specification for stabilization criteria and to define the location and extent of materials to be stabilized to meet the source control objectives for Operable Unit No. 1.

1.1 BACKGROUND

As described in the ROD, the remedial action components comprising Operable Unit No. 1 for the NBIA site include source control at the Eastern and Western Lagoons and protection of surface water quality in County Drain #30 from discharges of impacted groundwater emanating from the lagoons (Michigan Department of Environmental Quality and U.S. Environmental Protection Agency, June 1998). In the ROD, source control is effected through consolidation and containment of the lagoon materials and complemented by downgradient groundwater collection and treatment. The remedy defined by the ROD relied on the site conceptual model developed in the Remedial Investigation (RI) whereby it was understood that the majority of shallow groundwater discharged to County Drain #30 so that even low levels of leachable constituents in soils could adversely affect surface water in County Drain #30. As a result, when evaluating soil/sludge stabilization, the Feasibility Study (FS) assumed that large volumes of soils associated with the Western and Eastern Lagoons would need to be stabilized to accomplish the needed degree of source control to protect County Drain #30. The stabilization volumes were 132,500 cubic yards (based on a depth of 20 feet below ground surface) in the Western Lagoons, and 26,000 cubic yards (based on a depth of 10 feet below ground surface) in the Eastern Lagoons. Using these volumes, the resultant ROD rejected stabilization of the lagoon sludge as cost-prohibitive.

Hydrogeologic and other technical evaluations conducted since the issuance of the ROD have revised the site conceptual model. These more-recent studies have shown that County Drain #30 does not serve as the discharge point for the majority of impacted groundwater, and, as a result, USEPA and MDEQ have revisited the groundwater to surface water interface (GSI) criteria for local groundwater. To meet these revised GSI criteria, the volumes of impacted soils at the Eastern and Western Lagoons that could potentially leach constituents at concentrations contributing to exceedances of the revised GSI criteria are now believed to be significantly less than those estimated in the FS and ROD.

Table 1 summarizes these revised GSI criteria and the maximum concentrations observed in groundwater wells located in the vicinity of the Western and Eastern Lagoons. As shown in Table 1, cadmium concentrations exceed GSI criteria in groundwater in both the Western and

Eastern Lagoon Areas. Total cyanide concentrations are elevated in both lagoon areas as well, but free cyanide concentration data are not currently available for direct comparisons to the revised GSI criteria. Concentrations of all other constituents in groundwater currently achieve the revised GSI criteria, but not all of these concentrations currently comply with the site boundary goals set forth in the ROD. While lagoon sludge and soil stabilization is expected to reduce constituent concentrations in groundwater, it is not expected that such stabilization will be sufficient to achieve the site boundary cleanup goals. The stabilization process will not be specifically designed to eliminate volatile organic compounds (VOCs) contained in the lagoon wastes or adjacent soils. It is expected, however, that the stabilization process will reduce the concentrations of leachable VOCs in the waste due in large part to the reduced permeability of the stabilized material.

With lesser volumes, stabilization may be a cost-effective remedial treatment technology, and, during an August 26, 2005 conference call among representatives of USEPA, MDEQ, and the Group, stabilization of the metal plating sludge and impacted soils within the Eastern and Western Lagoons was discussed as a potential enhancement of the containment approach described in the ROD. On this basis, and as described in subsequent communications with USEPA, the Group is proposing to conduct the stabilization treatability study.

1.2 OBJECTIVES OF STABILIZATION

Consistent with USEPA guidance, as used in this SOW "stabilization" refers to a class of treatment processes designed to accomplish one or more of the following (U.S. Environmental Protection Agency, May 1989):[1]

- Improve the handling and physical characteristics of the waste (e.g., absorption of free liquids);
- Decrease the surface area of the waste mass across which transfer of constituents could occur; and
- Limit the solubility of hazardous constituents in the waste.

[1] Per the same USEPA guidance, "stabilization" and "solidification" are considered synonymous.

For the Eastern and Western Lagoons at the NBIA site, the goals of stabilization encompass all of these components.

In their present condition, the lagoon sludge does not provide suitable foundation conditions for placement of the soil cover specified in the ROD. While the impacted soil and dried sludge that comprise intervening and perimeter dikes appear to have satisfactory geotechnical properties, the wet sludge within the lagoons, especially the Western Lagoons, will require physical treatment even after supernatant removal to allow for soil cover placement. A key goal of NBIA lagoon stabilization is to render the sludge suitable as subgrade for a stable soil cover system. A corollary to this goal is the absorption of free liquids within the sludge to improve physical characteristics and to reduce potential leachate generation.

In addition to improving physical characteristics, an additional goal of stabilizing the NBIA lagoons is to minimize the contribution of lagoon sludge and impacted soil to groundwater contamination exceeding the revised GSI criteria for County Drain #30. This contribution is minimized by reducing the leachability of constituents of concern and the flow of groundwater through the stabilized material.

These stabilization goals translate into the following site-specific objectives:

- Provide adequate structural strength to support the soil cover and resist long-term settlement;
- Minimize free liquids associated with the lagoon sludge (following supernatant removal);
- Produce a stabilized material that does not leach constituents at concentrations that cause or contribute to exceedances of GSI criteria in groundwater and resulting impacts to County Drain #30; and
- Produce a reasonably homogenous material of decreased permeability (as compared to in situ soils) to reduce groundwater flow through the stabilized material.

1.3 OBJECTIVES OF TREATABILITY STUDY

The objective of the stabilization treatability study is to demonstrate that the lagoon sludge and associated soils can be physically and chemically stabilized in a manner that achieves the site-specific objectives using mixes formulated from readily available and commonly applied stabilizing agents. The results of a successful treatability will establish the design basis for a performance-based remediation contract specification for stabilization of the lagoon sludge and soils to meet the stated objectives and allow for the delineation of materials that require stabilization.

In particular, the stabilization treatability study will establish the design basis for the following performance criteria:

- Unconfined compressive strength;
- Leachable metals, free cyanide, total cyanide, and VOC concentrations, as determined by the Toxicity Characteristic Leaching Procedure (TCLP) test and by the Synthetic Precipitation Leaching Procedure (SPLP); and
- Permeability.

Other (secondary) performance factors to be established by the treatability study include the quantity of water consumed in the hydration of cementing agents, volume expansion, and VOC removal. To the extent practicable, and consistent with the primary performance criteria, the preferences are to: 1) maximize water uptake; 2) control volume expansion within an acceptable range; and 3) reduce leachable VOC concentrations by facilitating volatilization (e.g., by emphasizing exothermic reactions).

The following sections outline the tasks that comprise the lagoon sludge treatability study. These work tasks follow USEPA (May 1989) and U.S. Army Corps of Engineers (February 1995) guidance for stabilization treatability studies. The Group will solicit technical proposals from qualified consultants and contractors to conduct this study, and the consultant/contractor would be expected to suggest enhancements and refinements to the work tasks described herein.

2.0 TASK 1 – SAMPLING AND ANALYSIS

The first task of the treatability study is the sampling and analysis of lagoon sludge and soil to ensure that the materials to be employed in the subsequent bench- and pilot-scale testing conservatively represent in-situ materials associated with the Western and Eastern Lagoons. The Task 1 sampling and analysis will be conducted in accordance with the USEPA-approved *Pre-Design Studies Field Sampling and Quality Assurance Plan (Revised)* (January 18, 2001a) and *Health and Safety Plan* (January 18, 2001b) prepared by Arcadis Geraghty & Miller, Inc. (Arcadis). As needed, the consultant/contractor conducting the treatability study will prepare addenda to these plans describing any unique procedures or precautions associated with this sample collection and analysis.

2.1 FIELD SAMPLING

Samples of the lagoon sludge and associated soils will be collected that accurately represent the following six categories of materials

- Western Lagoon
  - Sludge;
  - Fill soil (i.e., upper silty soils mixed with dried sludge);
  - Native underlying sand;
- Eastern Lagoon
  - Sludge;
  - Fill soil (i.e., upper silty soils mixed with dried sludge);
  - Native underlying sand.

In addition to these materials, the source control remedy for NBIA Operable Unit No. 1 envisions that impacted sediments and bank soils from County Drain #30 will be stabilized and placed within the Western Lagoon Area. Sampling of the County Drain #30 sediments and bank soils are not specified as part of the stabilization treatability study, however, because the metals, cyanide, and VOC concentrations in the County Drain #30 sediments and bank soils are much lower than those found in lagoon sludge and soils. It is reasonably assumed that properties of the County Drain #30 sediments and bank soils will not govern the stabilization design.

The results of previous sampling (i.e., RI sampling by Warzyn, Inc. and pre-design sampling by Arcadis) will be reviewed to aid in the selection of appropriate sampling locations. The preferred sampling protocol is to collect discrete samples of each type of material and blend these discrete samples into large (i.e., 5- to 10-gallon) composite samples for each material. The locations of discrete samples will be biased toward locations where previous sampling had shown higher concentrations of cadmium, nickel, and other metals. Multiple composite samples will be formed of each type of sample to ensure sufficient sample volume is available for subsequent bench-scale testing.

In addition, discrete (not composited) samples representing each of these six materials will be collected for total VOC analysis. Discrete samples for VOC analysis will be selected based on field screening with a photoionization detector (PID), and samples exhibiting maximum PID readings will be selected for analysis.

Except for Western Lagoon sludge, samples will generally be collected using hand or power augers, with holes advanced to a maximum depth of about 6 feet. Depths are contingent on field conditions and may be revised as needed. Samples will be collected from auger cuttings or driven barrel-type samplers. In the Western Lagoons, a small boat will be used as needed to gain access for sludge sampling, and a specialty sludge sampler (e.g., piston-type, ponar dredge) will be used for sample collection. Samples will be collected in order to accurately represent in-situ lagoon conditions so that laboratory results will be representative of actual field conditions.

2.2 LABORATORY ANALYSIS

Samples of each of the collected materials will undergo initial laboratory analysis to establish pre-testing conditions. The laboratory conducting the analysis will be appropriately certified for any testing methods utilized. The analytical suite for these samples is provided in Table 2. As shown in Table 2, analytical techniques will generally be those identified in USEPA's "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (SW-846). For Task 1, quality assurance and quality control (QA/QC) procedures will be designed to develop definitive data of sufficient quality for engineering characterization as the baseline for subsequent stabilization treatability testing. The developed Task 1 data base will be compared to established QA objectives for accuracy, precision, and sensitivity of analysis and evaluated for completeness, representativeness, and comparability.

The results of the Task 1 analyses are expected to show total metals concentrations consistent with those observed in prior sampling efforts. If the Task 1 data do not corroborate prior sampling results, particularly if the Task 1 results show much lower total metals concentrations, a second sampling round (of reduced scope) may be necessary to ensure the materials subject to treatability testing adequately envelop the materials to be subjected to full-scale treatment. The degree to which these metals are leachable under either TCLP or SPLP extraction methods are not known at this time and will be evaluated from the Task 1 data.

3.0 TASK 2 - BENCH-SCALE SCREENING STUDY

The Task 2 bench-scale testing is designed to identify suitable reagents or combinations of reagents that can produce, at laboratory scale, mix designs that achieve the performance objectives set forth in Section 1.2. An important consideration in this stabilization mix evaluation is the sequencing of blending reagents and waste materials (i.e., sludge and soil). As needed, the consultant/contractor conducting the treatability study will prepare an addendum to the *Pre-Design Studies Field Sampling and Quality Assurance Plan (Revised)* describing the sample handling and laboratory procedures used in this bench-scale testing, as well as the confirmatory (Task 3) pilot-scale testing. QA objectives for data management and QC sample collection and testing protocols will be designed to develop definitive data of sufficient quality for engineering evaluations and decision-making with respect to: 1) the feasibility and cost-effectiveness of stabilization as a component of source control; and 2) acceptable mix design(s) to achieve cost-effective source control. As with Task 1, the developed Task 2 (and Task 3) data base will be compared to established QA objectives for accuracy, precision, and sensitivity of analysis and evaluated for completeness, representativeness, and comparability.

3.1 MIX DESIGNS

The consultant/contractor will withdraw aliquots of each of the composite samples to perform the bench-scale studies of physical and chemical stabilization. Mix designs will encompass the following range of additives and mixing sequences:

- Mix Design 1: Bulking of lagoon sludge with impacted soil (i.e., both upper fill soils and sand) with no additives;
- Mix Design 2: Pretreatment of lagoon sludge at various addition rates of Portland cement or other lime-based agents, followed by bulking with impacted soils;
- Mix Design 3: Pretreatment of lagoon sludge at various addition rates of buffered phosphate compounds, followed by bulking with impacted soils;
- Mix Design 4: Post-treatment of Mix Design 2 mixtures with various addition rates of buffered phosphate compounds; and
- Mix Design 5: Post-treatment of Mix Design 3 mixtures with various addition rates of Portland cement or other lime-based agents.

The consultant/contractor may propose additional candidate mixes, involving other stabilizing agents and/or mixing sequences.

Each of the mix designs (except Mix Design 1) involves varying rates of reagent addition. For mixes that use cementing agents, addition rates are generally in the range of 5 to 20 percent, and a typical experimental design could involve preparation of mixes at 5-, 10-, 15-, and 20-percent cementing agent addition. In this testing, it is envisioned that Portland cement will be used as the cementing agent, although other lime-based reagents (e.g., calcined lime, cement kiln dust) could be substituted. For mixes that use buffered phosphate compounds, addition rates are typically much lower, in the range of 1 to 8 percent, and a typical experimental design could involve preparation of mixes at 1, 3, 5, and 8-percent addition. It is envisioned that commercially available buffered phosphate stabilizing agent (e.g., EnviroBlend®) will be used in the bench-scale treatability testing.

The materials included in each mix design will be thoroughly blended and cured under controlled conditions, e.g., conditions used for test curing of concrete mixes under the American Society for Testing and Materials (ASTM) Method D1633. Sufficient quantities of each mix design will be prepared to provide for the mix evaluation testing described in Section 3.2.

3.2 MIX EVALUATIONS

The bench-scale testing will examine the following characteristics associated with the prepared samples representing each mix design:

- Presence of free liquids;
- Structural strength;
- Leachability; and
- Hydraulic conductivity.

Consumption of water (by hydrating the added cement) and volume expansion in stabilization will also be investigated. Table 3 summarizes the testing methods that will be used to evaluate the performance of the various mix designs.

3.2.1 Free Liquid and Moisture Content

A primary objective in stabilization is to eliminate free liquids associated with the untreated material. For effective long-term stabilization, the elimination of free liquids should involve both reduction of the water content by the addition of dry solids and the consumption of free water in the hydration of the added cementing agents. In reacting with the cement, the water becomes chemically bonded in the stabilized matrix.

In this treatability study, the elimination of free liquids will be evaluated in two ways:

- Direct testing of stabilized materials using the Paint Filter Test (SW-846 9095A), within 24 hours of initial mixing; and
- Examination of changes before and after stabilization in moisture content as determined by ASTM Method D2216.

For each mix design, treated material samples containing the lowest agent addition rates will be used in testing. If these samples all pass the paint filter test, and if visual inspection of other samples show no free liquids present, further testing for free liquid will not be required.

In addition to the Paint Filter Testing, changes in the moisture content of materials undergoing stabilization will be evaluated. The moisture contents of the materials treated with cementing agents (i.e., Mix Designs 2, 4, and 5) will be determined in accordance with ASTM Method D2216, and these data will be used to estimate the amount of free water consumed in hydrating the cement as a percent of the weight of cementing agent added.

The moisture content data will also be used to estimate the volume expansion associated with the cement stabilization of the material according to the specific stabilization mix design. This evaluation will include a comparison of specific gravity measurements of untreated materials to the specific gravities of treated materials.

3.2.2 Structural Strength

Preliminary strength testing will be conducted of the mixed samples; a pocket penetrometer or torvane can be used for this testing. The penetrometer or torvane will be used to determine the strength of each mixed sample at the following times following mixing:

- 1 hour;
- 3 hours;
- 6 hours;
- 24 hours;
- 3 days;
- 7 days; and
- 28 days.

Further penetrometer or torvane measurements on any mixed sample may be suspended once the observed penetration or torvane resistance reaches full span (i.e., greater than about 50 pounds per square inch).

Determinations of the unconfined compressive strength of the treated samples will be performed by triaxial compression testing (ASTM D2850) 28 days after mixing. A sufficient number of triaxial compression tests will be made to allow correlations to penetrometer (or torvane) readings and to confirm that the various mix designs can achieve structural characteristic suitable to provide stable subgrade conditions at both the Western and Eastern Lagoons. Mixed samples will be properly cured and stored in accordance with ASTM D1633 throughout the 28-day strength development period.

3.2.3 Leachability

After a minimum 28-day cure, treated samples representing each of the mix designs will be subjected to leachability testing using TCLP and SPLP. Samples selected for leachability testing will include only those mix designs shown to be capable of minimizing free liquids and achieving favorable geotechnical properties.

Leachate samples will be analyzed for the same metals that were analyzed for the untreated samples (Table 3), and the SPLP samples will be analyzed for leachable total and free cyanide. Selected samples will also be analyzed for leachable VOC concentrations using a TCLP zero headspace extraction.

3.2.4 Hydraulic Conductivity

Samples of treated materials representing mix designs that show favorable results with respect to structural properties and leachability will be tested for hydraulic conductivity using the flexible-wall permeameter method defined by ASTM D5084. Hydraulic conductivity sampling will be conducted on samples cured for not less than 28 days in accordance with ASTM D1633.

3.3 MIX SELECTION

Based on the results of the mix evaluations, preliminary stabilization performance criteria will be defined with respect to each of the parameters identified in Section 1.3. One or more mix designs that achieve these criteria will then be selected for pilot-scale testing.

The identified performance criteria may vary for the Western and Eastern Lagoons, especially with respect to structural strength. The Eastern Lagoons are located on an active industrial site, and the strength criteria for stabilization of the Eastern Lagoons will consider the potential for use of this lagoon area following remediation for future industrial activity (e.g., parking or loading areas). It is also likely that the mix designs to achieve stabilization performance criteria will differ for the Western and Eastern Lagoons.

4.0 TASK 3 – FIELD PILOT STUDY

The Task 3 field pilot study is an extension of the bench-scale testing and is designed to evaluate issues related to implementability of the stabilization mix designs identified in the laboratory. The field-pilot-scale program is specifically designed to confirm that conventional construction equipment can mix sludge, soils, and stabilization reagents adequately to achieve a relatively homogenous material and that the bench-scale mix is suitable for sludge and soils located both above and below the groundwater table.

4.1 EASTERN LAGOONS

It is proposed to initiate the field pilot study in the Eastern Lagoon area because the lagoon sludge is more readily accessible in this location. The pilot study will begin by constructing a test cell within the limits of the Eastern Lagoon. To build this test cell, the top of the berm separating the northern and southern lagoons will be removed as needed, and the work area will then be graded to form a suitable work platform. Using a backhoe or small hydraulic excavator, a pit will then be excavated into the berm to form the test cell. The volume of the test cell will be 9 cubic yards, based on an excavation 3 feet wide by 9 feet long and 9 feet in depth. At that depth, approximately half of the test cell volume will be below the groundwater table. No personnel entry will be allowed within the excavation, and the excavation sidewalls will be excavated as nearly vertical as possible.

After excavation, the test cell will be filled with a representative blend of materials for pilot-scale testing. Sludge from the northern and southern portions of the Eastern Lagoons will be excavated and mixed with the berm soil, underlying native sand, and stabilization agents in accordance with the selected mix design (Section 3.3). The stick and bucket of the backhoe or excavator will be used to add and blend the mix components.

After mixing, two temporary wells will be installed adjacent to the test cell. The temporary wells will each extend to a nominal depth of 10 feet below grade with 5-foot slotted well screens. The wells will be installed using conventional well installation methods or by Geoprobe® and pre-packed well screens. After developing, water levels will be measured in the wells to confirm the depth to groundwater.

The stabilized material within the test cell will be sampled at 28 days after mixing to evaluate chemical and physical properties. A Geoprobe® will be used to collect core samples from materials located both above and below the groundwater table. Groundwater samples from the temporary wells will be sampled at the same time.

For the stabilized materials, testing parameters and methods will be the same as those used for mix design evaluations as discussed in Section 3.2 and summarized in Table 3. Some field-scale methods substitutions (e.g., cone penetrometer, rising head permeability) may be employed to allow for more representative sampling. Groundwater samples will be collected and analyzed for metals, cyanide (total and free), and VOCs using USEPA methods.

4.2 WESTERN LAGOONS

Pending the successful completion of the Eastern Lagoon pilot study, a similar pilot study will be conducted in the Western Lagoon area. Here the test cell will be constructed in the southeastern portion of the Western Lagoon area. The top of the berm between the two lagoons in the southeast area will be removed as needed, and the work area graded to form a suitable work platform. Using a backhoe or small hydraulic excavator, a pit will then be excavated to form the test cell. The volume of this test cell will be 21 cubic yards based on an excavation 4 feet wide by 12 feet long and 12 feet in depth. This depth is needed to allow approximately half of the test cell volume to be below the groundwater table. No personnel entry will be allowed within the excavation, and the excavation sidewalls will again be excavated as nearly vertical as possible.

The same mixing, temporary well installation, and testing protocol will be then be employed for the Western Lagoon as were done for the test cell at the Eastern Lagoons.

5.0 TASK 4 – DATA EVALUATION AND REPORTING

The results of the lagoon sludge treatability study will be compiled in a comprehensive report for use by the Group in Remedial Design. The report will provide descriptions of the following:

- Selection of sampling locations, sample collection, and handling;
- Initial sample characterization
- Bench-scale test program, including, sample preparation and curing, mixing and testing, and physical and chemical and physical test results;
- Selection of final mixes for field pilot testing;
- Pilot-scale testing field implementation methods;
- Pilot-scale testing observations and physical and chemical test results; and
- Conclusions.

The conclusions of the report will include an engineering evaluation of the unit costs of acceptable stabilization mix designs, including an evaluation of unit cost sensitivity with design and volume.

A successful lagoon sludge treatability study will result in the following:

- The identification of one or more mix designs that will achieve the site-specific stabilization objectives set forth in Section 1.2; and
- The definition of attainable and workable stabilization performance criteria with respect to structural strength, leachability, and permeability.

If these objectives can be achieved, the results of the treatability study will also be used in the reevaluation of the location and extent of materials that require stabilization to achieve the surface water goals in County Drain #30. In particular, the leachability and permeability data will be used to develop a near-field flow net and transport model to assess the contribution of both treated and residual untreated materials to County Drain #30. From this assessment, the limits of materials requiring stabilization will be determined based on physical location and chemical (e.g., total metals and cyanide concentrations) characteristics.

REFERENCES

Arcadis Geraghty & Miller, Inc., January 18, 2001a. "Pre-Design Studies Field Sampling and Quality Assurance Plan (Revised)," Appendix B to "Pre-Design Studies Work Plan, Operable Unit 1, North Bronson Industrial Area Site."

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TABLES

Table 1
Revised Groundwater to Surface Water Interface (GSI) Criteria, Site Boundary Goals, and Observed Concentrations in Local Groundwater

Constituent	GSI Criteria (ug/L)[1]		Site Boundary Cleanup Goal (ug/L)[2]	Observed Concentrations in Groundwater[3]			
				Western Lagoons		Eastern Lagoons	
	Acute Concentration	Chronic Concentration		Well No.	Concentration (ug/L)	Well No.	Concentration (ug/L)
1,2-dichlorotheylene (total)	19,000	3,700	NS[4]	--	NM[5]	--	NM
cis-1,2-dichloroethylene	NS	NS	70	MW-8D	680	MW-17D	120
Ethylbenzene	320	61	NS	--	ND[6]	--	ND
Tetrachloroethylene	710	150	NS	--	ND	--	ND
Trichloroethylene	3,500	670	5	MW-30	430	MW-16D	180
Vinyl chloride[7]	NS	200	2	MW-8S	120	MW-34I	69
Xylene	630	120	NS	--	ND	--	ND
Cadmium[8]	48	31	5	MW-32S	***51***	MW-18	***110***
Copper	96	90	NS	MW-32S	27	MW-17D	19
Lead	2,200	410	4	--	ND	--	ND
Nickel	4,000	740	100	MW-32S	690	MW-18	460
Zinc	1,100	NS	2,400	MW-7S	47	MW-17S	132
Cyanide (free)[9]	44	18	NS	--	NM	--	NM
Cyanide (total)[9]	NS	NS	200	MW-32I	2,100	MW-34I	52
Nitrate + Nitrite	NS	NS	10,000	MW-6S	18,000	MW-35S	20,000

Notes:

1 *Revised GSI Criteria provided by USEPA via letter dated March 1, 2006.*
2 *Site boundary criteria specified in ROD Table 3.*
3 *Groundwater data from RI and pre-design sampling. Only most-recent data considered for wells subjected to multiple sampling rounds.*
4 *"NS" indicates no standard.*
5 *"NM" indicates not measured in groundwater sampling*
6 *"ND" not detected; reporting limits vary.*
7 *Additional ROD cleanup goals for vinyl chloride are 110 ug/L for indoor inhalation and 290 ug/L for groundwater contact.*
8 *Values in **bold italic** type exceed either acute or chronic GSI criteria concentrations.*
9 *Cyanide comparisons to GSI criteria cannot be made with currently available data.*

Table 2
Analytical Testing Program for Lagoon Sludge and Soil Samples

Parameter		Units	Analytical Method[1, 2]	Target Reporting Limit[3]
General Chemistry and Physical Properties	pH	s.u.	9045C	NA
	Moisture Content	Percent	ASTM D2216	NA
	Specific Gravity	g/cm^3	ASTM E868	NA
	Free Liquids (Paint Filter Test)	NA	9095A	NA
	Total Cyanide	mg/kg	9012A	0.5
	Free (Amenable) Cyanide	mg/kg	9012A	0.5
Total Metals	Cadmium	mg/kg	6010B	0.2
	Copper	mg/kg	6010B	2.5
	Lead	mg/kg	6010B	0.3
	Nickel	mg/kg	6010B	4
	Zinc	mg/kg	6010B	2
TCLP (Method 1311) and SPLP (Method 1312) Metals and Cyanide[4]	Arsenic	ug/L	6010B	15
	Barium	ug/L	6010B	10
	Cadmium	ug/L	6010B	5
	Chromium (total)	ug/L	6010B	10
	Copper	ug/L	6010B	10
	Lead	ug/L	6010B	3
	Mercury	ug/L	7471A	0.2
	Nickel	ug/L	6010B	40
	Selenium	ug/L	6010B	15
	Silver	ug/L	6010B	10
	Zinc	ug/L	6010B	20
	Total Cyanide	ug/L	EPA 335.4[5]	10
	Free Cyanide	ug/L	EPA 335.2 (modified)[5]	10

Table 2
Analytical Testing Program for Lagoon Sludge and Soil Samples

Parameter		Units	Analytical Method[1, 2]	Target Reporting Limit[3]
Volatile Organic Compounds (VOCs)	Cis-1,2-dichloroethylene	ug/kg	8260C	0.5
	Trans-1,2-dichloroethylene	ug/kg	8260C	0.5
	Ethylbenzene	ug/kg	8260C	1
	Tetrachloroethylene	ug/kg	8260C	1
	Trichloroethylene	ug/kg	8260C	1
	Vinyl Chloride	ug/kg	8260C	2
	Xylene (total)	ug/kg	8260C	2
TCLP Zero Headspace (Method 1311) VOCs	Cis-1,2-dichloroethylene	ug/L	8260C	0.5
	Trans-1,2-dichloroethylene	ug/L	8260C	0.5
	Ethylbenzene	ug/L	8260C	1
	Tetrachloroethylene	ug/L	8260C	1
	Trichloroethylene	ug/L	8260C	1
	Vinyl Chloride	ug/L	8260C	2
	Xylene (total)	ug/L	8260C	2

Notes:

[1] *Methods are from USEPA SW-846 unless otherwise specified.*
[2] *The most recent method update shall be used for all analyses.*
[3] *Actual reporting limits may vary due to matrix interferences or other factors.*
[4] *Total and free cyanide are to be analyzed in the SPLP extract only.*
[5] *Method given in U.S. Environmental Protection Agency, March 1983 (as updated).*

Table 3
Test Methods for Stabilization Mix Design Evaluations

Parameter	Units	Test Method[1, 2]
Free Liquids (Paint Filter Test)	NA	SW-846 9095A
Moisture Content	Percent	ASTM D2216
Specific Gravity	g/cm^3	ASTM E868
Structural Strength		
Penetrometer or Torvane	psi	Manufacturer's Specifications
Unconfined Compressive Strength	psi	ASTM D2850
Leachability		
TCLP and SPLP Metals (SW-846 1311 / 1312)		
Arsenic	ug/L	SW-846 6010B
Barium	ug/L	SW-846 6010B
Cadmium	ug/L	SW-846 6010B
Chromium (total)	ug/L	SW-846 6010B
Copper	ug/L	SW-846 6010B
Lead	ug/L	SW-846 6010B
Mercury	ug/L	SW-846 7471A
Nickel	ug/L	SW-846 6010B
Selenium	ug/L	SW-846 6010B
Silver	ug/L	SW-846 6010B
Zinc	ug/L	SW-846 6010B
Total Cyanide (SPLP only)	ug/L	EPA 335.4
Free Cyanide (SPLP only)	ug/L	EPA 335.2 (modified)
TCLP Zero Headspace VOCs (SW-846 1311)		
Cis-1,2-dichloroethylene	ug/L	SW-846 8260C
Trans-1,2-dichloroethylene	ug/L	SW-846 8260C
Ethylbenzene	ug/L	SW-846 8260C
Tetrachloroethylene	ug/L	SW-846 8260C
Trichloroethylene	ug/L	SW-846 8260C
Vinyl Chloride	ug/L	SW-846 8260C
Xylene (total)	ug/L	SW-846 8260C
Hydraulic Conductivity	cm/sec	ASTM D5084

Notes:

[1] *Analytical reporting limits are those shown in Table 2.*

[2] *The most recent method update shall be used for all analyses.*